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NOISE REMOVAL IN BRAIN MRI IMAGE

N.Rajeswaran[1], C.Gokilavani[2], S.Arumugam[3] and V.Ramaraju[4]

Abstract—The medical images original information are affected by the various noises and blurs the features which are essential for the verdict of the illness of the human body. Brain images are fractal in nature and especially in brain MRI (Magnetic Resonance Imaging) images; Salt and Pepper noises affect the important features. To reduce the effect of Salt and Pepper noise in brain MRI images by implementing wavelet based thresholding techniques namely Visu shrink, SURE shrink and Bayes shrink. The proposed techniques performances are compared by using various evaluation metrics.

Keywords—Noises, Brain MRI Images, Denosing, Wavelet Thresholding

I. INTRODUCTION

Recently, medical image processing, is attracting many researchers and is using in various medical fields. Mainly MRI (Magnetic Resonance imaging) images are most commonly used in different disease treatment. But the main problem in those images is presence of various noises. The noises create the wrong information for the user and make them inaccurate treatment. Hence, the content of the information should be noise free in nature and available good in accuracy. Image restoration is the larger part of the image processing and in other words is called as image denoisng. In image denosing, the noise affected images plays a most important function to detect the diseases in a appropriate manner and to keep the image up to its excellence [1-2].

This Image denoising is used to eliminate and reduce the noises present in an image and retain the originality of the image back. While preserving the images, the important features are needed for proper diagnosis and in the direction of track the progress of the diseases effectively. This method is very helpful to find many filed such as astronomy, forensic science and so on. Also the tradeoff between the image features and noise reduction must be taken into account while denoising [3]. Recently, soft computing technique is applied for noise removal and reduction in MRI images [4].

II. IMPLEMENTATION

The MRI images are different form normal images. Also, the Medical images are taken by MRI (Magnetic Resonance imaging), CT (Computed Tomography) and Ultrasound imaging [5]. The above all methods are having own merits and demerits in different real time applications. Among these MRI sounds better in giving high resolution images of the soft tissues in human body. The complex organ structure of the human body is Brain [6]. Hence, an image of human brain consists of several complex patterns that are independent of scales. Thus brain image is a self similar structure and is fractal in nature. Various types of noises are present in brain MRI images. They include salt and pepper noise, Gaussian noise, speckle noise and fractional Brownian motion noise (fBm noise) [7].

III. PROPOSED SYSTEM DESIGN

The performance of the denoising techniques is evaluated by different parameters and their formulae are given below. The formula for MSE (Mean Square Error) is given by,

[1] *Dept. of EEE, Malla Reddy Engineering College (A), Maisammaguda, Secunderabad, India*
[2] *Dept. of ECE, SNS College of Tech., Coimbatore,India vanichinnasamysv@gmail.com*
[3] *Dept. of EEE, Malla Reddy Engineering College (A), Maisammaguda, Secunderabad, India*
[4] *Dept. of ECE, Vishnu Inst., of Tech.,Vishnupur,Bhimavaram Andhrapradesh, India*

$$MSE = \frac{1}{MN}\sum_{j=1}^{M}\sum_{k=1}^{N}(x_{j,k} - x'_{j,k})^2 \quad (1)$$

The formula for PSNR (Peak to Signal Noise Ratio) is given by,

$$PSNR = 10log\frac{(255)^{\wedge}2}{MSE} \quad (2)$$

Where, xj,k represents the original image and x’j,k represents the restored image. The formula for Normalized Cross Correlation (NK) is given by,

$$NK = \sum_{j,k}^{M}\sum_{j,k}^{N} x_{j,k}.x'_{j,k} / \sum_{j,k}^{M}\sum_{j,k}^{N} x_{j,k}^2 \quad (3)$$

The formula for Average Difference (AD) is given by,

$$AD = \sum_{j=1}^{M}\sum_{k=1}^{N}(x_{j,k} - x'_{j,k}) / MN \quad (4)$$

The formula for Structural Content (SC) is given by,

$$SC = \sum_{j=1}^{M}\sum_{k=1}^{N} x_{j,k}^2 / \sum_{j=1}^{M}\sum_{k=1}^{N} x'^2_{j,k} \quad (5)$$

The formula for Maximum Difference (MD) is given by,

$$MD = Max(|x_{j,k} - x'_{j,k}|) \quad (6)$$

The formula for Normalized Absolute Error (NAE) is given by,

$$NAE = \sum_{j=1}^{M}\sum_{k=1}^{N}|x_{j,k} - x'_{j,k}| / \sum_{j=1}^{M}\sum_{k=1}^{N}|x_{j,k}| \quad (7)$$

The IEF (Image Enhancement Factor) is given by, IEF= (Noisy Image – Original Image)/ Denoised Image-Original Image)

Where,

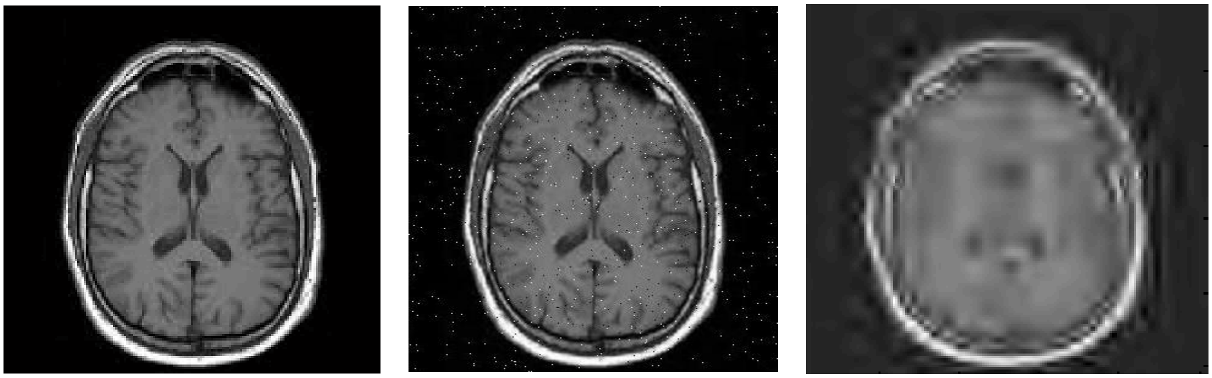
- μ_x the average of x
- μ_y the average of y
- σx^2 the variance of x
- σy^2 the variance of y
- σ xy the covariance of x and y
- $c_1=(K1L)^2$, $c_2=(K2L)^2$ two variables to stabilize the division with weak denominator
- L the dynamic range of the pixel-values
- $K_1=0.01$ and $K_2=0.03$ by default

IV. RESULTS AND DISCUSSIONS

Three methods are used here for the removal of various noises presented in Brain MRI Image. In this paper Salt and Pepper noises are only considered for the simulation. The proposed methods are Visu Shrink, SURE Shrink and Bayes Shrink. The comparisons of all the three techniques are given in Table 1.

Method I: The first method in this design is Visu shrink and the obtained simulation output of Brain MRI images are given in Fig. 1. The original Brain MRI image is presented Fig. 1.(a) and also affected image is shown in The Fig. 1.(b). The denosing technique is applied to the noisy images and the denoised image is given in Fig. 1.(c)

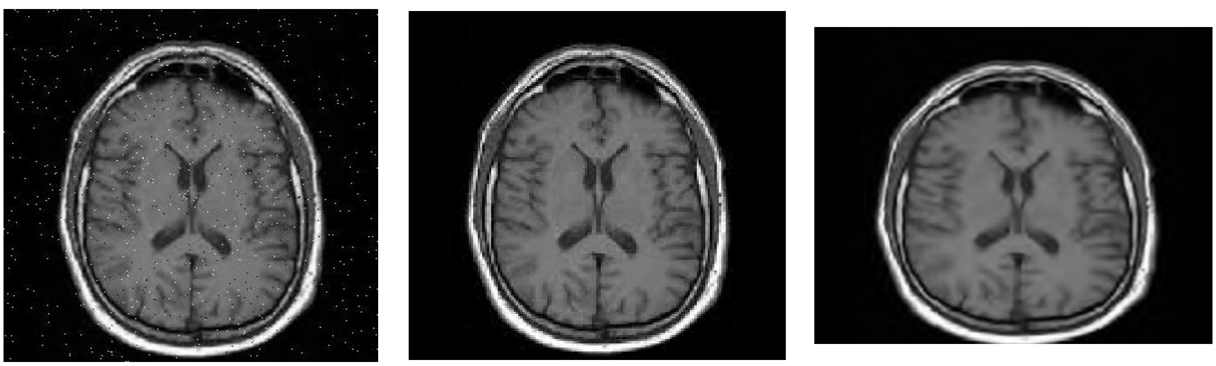
The proposed technique is used the Hurst parameter is 0.19 (for a classical Brownian motion, the Hurst parameter h=0.21) for noisy images.



(a) (b) (c)

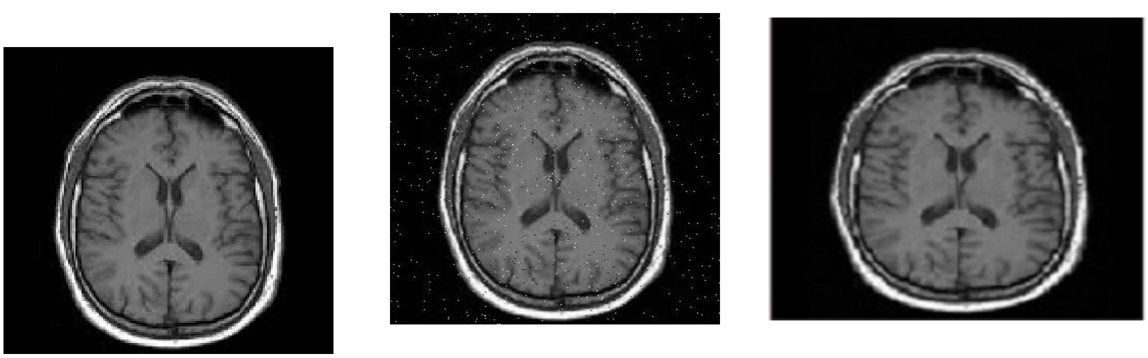
Figure1: (a) Original Image (b) noisy image (c) Denosied image

Method II: The obtained simulations outputs for SURE shrink are given in Fig. 2. The actual brain MRI images is given in Fig. 2.(a). The affected (Noise) is shown in Fig 2.(b). The original image after denosing technique applied by SURE shrink is presented in Fig. 2.(c). The 'H' (Hurst Parameter) value assigned by the affected images is 0.19.



(a) (b) (c)

Figure2: (a) Actual Image (b) Affected image (c) Denosied image



(a) (b) (c)

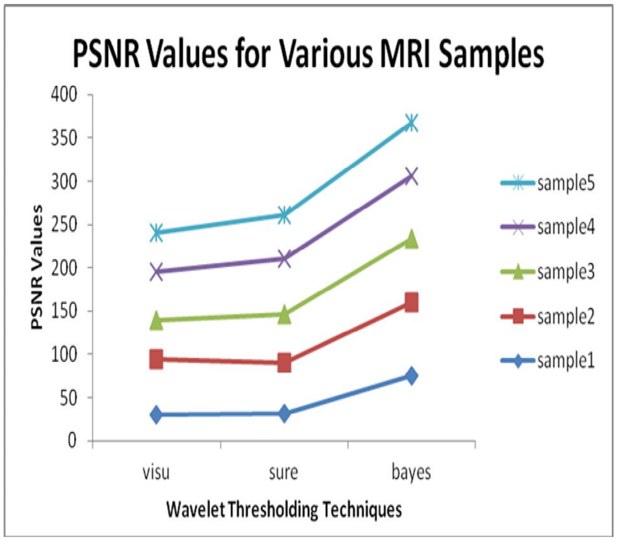
Figure 3: (a) Actual Image (b) Affected image (c) Denosied image

Method III: The effective design output for Bayes shrink are given in Fig.3. The actual, affected and denoised images are presented from Fig.3.(a) to Fig.3.(c). In this technique also 'H' value is assigned 0.9.

Table -1 Comparison of Different Methods

.NO	PERFORMANCE METRICS	VISU SHRINK	SURE SHRINK	BAYES SHRINK
1	MSE (Mean Square Error)	0.6465e+02	0.2525e+02	0.1854e-02
2	PSNR (Peak signal to Noise ratio)	30.6565	50.2111	80.2442
3	FD(Fractal Dimension)	1.9854	1.9524	1.9921
4	IEF(Image Enhancement Factor)	1.2545	1.5456	9.6821
5	SSIM (Structural Similarity Index)	1.000	0.6554	1.000
6	NK(Normalized Cross Correlation)	0.6542	0.9242	0.9218
7	AD(Average Difference)	214	198	65
8	SC (Structural Content)	1.0000	1.0000	1.0000
9	MD(Maximum Difference)	255	222	255
10	NAE(Normalized Absolute Error)	0.6545	0.0525	0.0021
11	Time Elapsed when attempt to denoise	1.2505sec	8.5511sec	1.0565sec

The obtained results are given from Figs. 4 to Figs. 8. The results are clearly proved the efficiency of the proposed technique in brain MRI images.



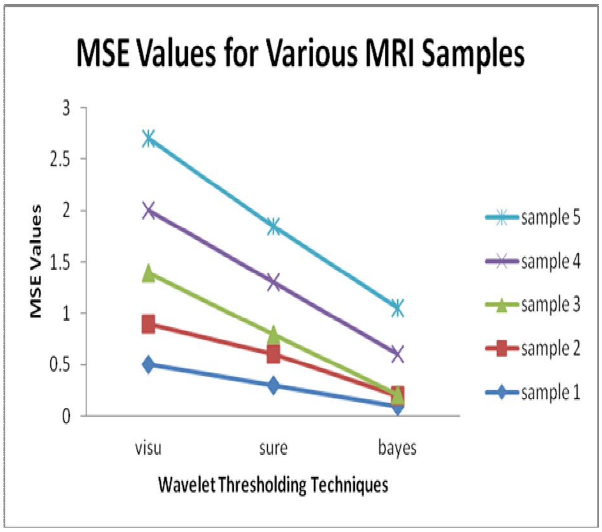


Figure 5: MSE Comparison Chart

Figure 4: PSNR Comparison

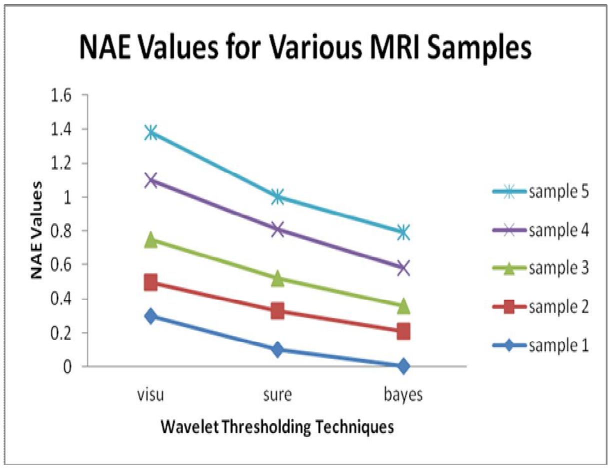


Figure 6: NAE Comparison Chart

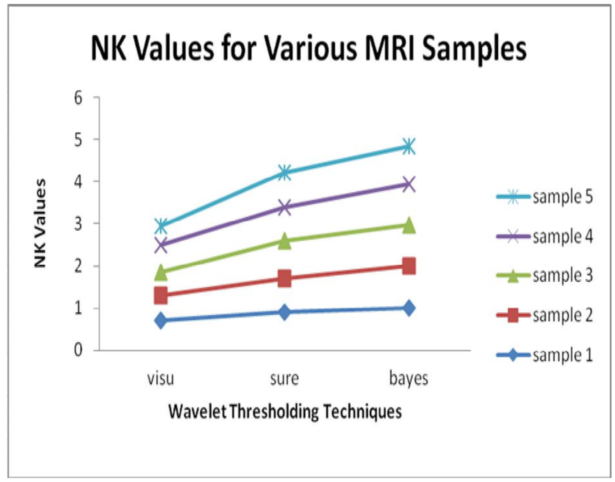


Figure.7. NK Comparison Chart

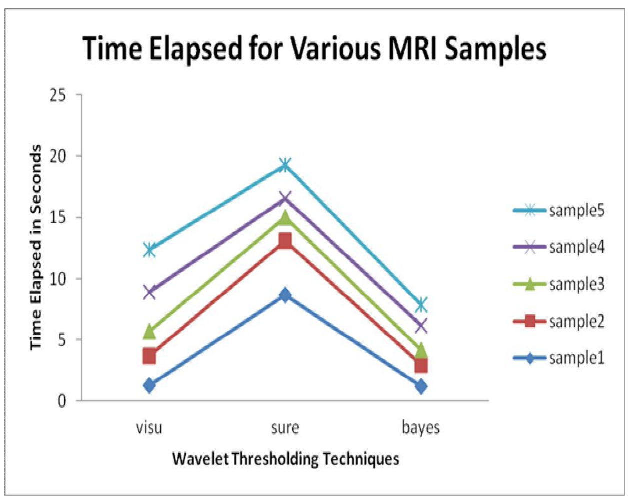


Fig.8. Time Elapsed to produce denoised image

V. CONCLUSION

The three different wavelet thresholding techniques are proposed in this paper for elimination of various noises in Brain Magnetic Resonance Imaging. The presented results are simulated by using MATLAB simulation software. The Bayes shrink method performed better in terms of all performance metrics compared with other methods. It has high PSNR, lowest MSE and lower NAE. In future different filtering technique may be used for better results in MRI images.

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